CLAIMS

What is claimed is:

1. A fabrication method for a MEMS-based fuel cell using a fuel and an oxidant, the method comprising the steps of:

a) providing a substrate;

b) depositing an electrolyte upon the substrate;

c) depositing and patterning a cathode in contact with the electrolyte;

d) depositing and patterning an anode spaced apart from the cathode and in contact with the electrolyte; and

e) forming a chamber extending over at least a portion of at least one of the cathode and anode, the chamber including at least one integral manifold for at least one of the fuel and oxidant.

2. The method of claim 1, further comprising the step of:

f) patterning the electrolyte.

3. A fuel cell made by the method of claim 1.

4. The method of claim 1, wherein the chamber extends over at least the entire anode.

5. The method of claim 1, wherein the electrolyte-depositing step b) comprises depositing a solid-oxide electrolyte.

6. The method of claim 1, wherein the electrolyte-depositing step b) comprises depositing a proton-exchange-membrane (PEM) electrolyte.

7. The method of claim 1, wherein the chamber-forming step e) comprises the substeps of:

i) depositing a layer of sacrificial material;

ii) patterning the sacrificial material;

iii) covering the sacrificial material with a suitable material to form a chamber roof; and

iv) removing the sacrificial material.

8. The method of claim 7, wherein the suitable material is an electrolyte.

9. The method of claim 7, wherein the suitable material is a non-electrolyte.

10. A fuel cell made by the method of claim 7.

11. The method of claim 1, wherein the chamber-forming step e) comprises the substeps of:

i) forming a porous electrode; and

ii) covering the porous electrode with a suitable material to form a chamber roof.

12. The method of claim 11, wherein the suitable material is an electrolyte.

13. The method of claim 11, wherein the suitable material is a non-electrolyte.

14. The method of claim 1, wherein the chamber-forming step e) comprises the substeps of:

i) depositing and patterning a planar film of an oxidizable material; and

ii) oxidizing the oxidizable material to form a chamber roof.

15. The method of claim 14, further comprising the substep of:

iii) depositing and patterning an inert material to form an anchoring portion to hold a peripheral portion of the oxidizable material in contact with the electrolyte.

16. The method of claim 1, wherein the steps are performed in the order recited.

17. The method of claim 1, wherein the electrolyte-depositing step b) is performed after chamber-forming step e).

18. The method of claim 1, wherein the chamber-forming step e) includes tape casting the electrolyte.

19. The method of claim 1, wherein the chamber-forming step e) comprises the substeps of:

i) providing an unfired tape of electrolyte material carrying the cathode and anode, the tape having first and second sides;

ii) providing a mold for forming a desired shape for the chamber;

iii) coating both first and second sides of the unfired tape of electrolyte material carrying the cathode and anode with a suitable solvent;

iv) pressing the unfired tape of electrolyte material carrying the cathode and anode to form the desired chamber shape; and

v) co-firing the assembled and shaped elements to form the chamber.

20. The method of claim 19, wherein the cathode-depositing-and-patterning step c) is performed before unfired-tape-providing substep i) by depositing and patterning a cathode material on at least one side of an unfired tape of electrolyte material.

21. The method of claim 19, wherein the cathode-depositing-and-patterning step c) is performed by printing the cathode material on at least one side of an unfired tape of electrolyte material.

22. The method of claim 19, wherein the anode-depositing-and-patterning step d) is performed before unfired-tape-providing substep i) by depositing and patterning an anode material on at least one side of an unfired tape of electrolyte material.

23. The method of claim 19, wherein the anode-depositing-and-patterning step d) is performed by printing the anode material on at least one side of an unfired tape of electrolyte material.

24. The method of claim 19, wherein the cathode-depositing-and-patterning step c) is performed by printing the cathode material on the first side of an unfired tape of electrolyte material, and wherein the anode-depositing-and-patterning step d) is performed by printing the anode material on the second side of the unfired tape of electrolyte material.

25. The method of claim 19, wherein the cathode-depositing-and-patterning step c) is performed by printing the cathode material on the first side of an unfired tape of electrolyte material, and wherein the anode-depositing-and-patterning step d) is performed by printing the anode material on the first side of the unfired tape of electrolyte material.

26. The method of claim 25, wherein the cathode-depositing-and-patterning step c) is further performed by printing the cathode material on the second side of an unfired tape of electrolyte material, and wherein the anode-depositing-and-patterning step d) is further performed by printing the anode material on the second side of the unfired tape of electrolyte material.

27. The method of claim 19, wherein the suitable solvent comprises a solvent selected from the list consisting of isopropyl alcohol, water, ethyl alcohol, methyl alcohol, methyl ethyl ketone, and mixtures and solutions thereof.

28. The method of claim 1, further comprising the step of:

f) removing at least a portion of the substrate under the anode and cathode, leaving a supporting membrane portion.

29. The method of claim 1, further comprising the step of:

g) forming a first opening through the substrate under the chamber, the first opening communicating with the chamber.

30. The method of claim 29, wherein the first opening is adapted for flow of at least one of the fuel and oxidant into the chamber.

31. The method of claim 29, further comprising the step of:

h) forming a second opening through the substrate under the chamber, the second opening communicating with the chamber.

32. The method of claim 31, wherein the second opening is adapted for flow of at least one of the fuel and oxidant into the chamber.

33. The method of claim 31, wherein the second opening is adapted for exhaust flow of at least one of depleted fuel and depleted oxidant out of the chamber.

34. The method of claim 31, further comprising the step of:

j) forming a third opening through the substrate under the chamber, the third opening communicating with the chamber.

35. The method of claim 34, wherein the third opening is adapted for exhaust flow of at least one of depleted fuel and depleted oxidant out of the chamber.

36. A fabrication method for a MEMS-based fuel cell using a fuel and an oxidant, the method comprising the steps of:

a) providing a substrate;

b) depositing an electrolyte upon the substrate;

c) depositing and patterning a cathode in contact with the electrolyte;

d) depositing and patterning an anode spaced apart from the cathode and in contact with the electrolyte;

e) forming a first chamber extending over at least the anode, the first chamber including an integral manifold for the fuel;

f) forming a second chamber extending over at least the cathode, the second chamber including an integral manifold for the oxidant;

g) removing at least a portion of the substrate under the anode and cathode, leaving a membrane portion;

h) forming a first opening through the substrate under the first chamber, the first opening communicating with the first chamber, whereby the first opening is adapted for flow of fuel into the first chamber; and

i) forming a second opening through the substrate under the second chamber, the second opening communicating with the second chamber, whereby the second opening is adapted for flow of oxidant into the second chamber.

37. The method of claim 36, wherein the steps are performed in the order recited.

38. A fuel cell made by the method of claim 36.

39. The method of claim 36, further comprising the step of:

j) patterning the electrolyte.

40. The method of claim 36, wherein the membrane portion has a periphery, and the membrane portion is supported around its entire periphery.

41. The method of claim 36, wherein at least part of the membrane portion is removed so as to leave the membrane portion cantilevered.

42. A MEMS-based fuel cell of the type using a fuel and an oxidant, the fuel cell comprising:

a) a substrate;

b) an electrolyte in contact with the substrate;

c) a cathode in contact with the electrolyte;

d) an anode spaced apart from the cathode and in contact with the electrolyte;

e) at least one chamber extending over at least a portion of at least one of the cathode and anode, the at least one chamber including an integral manifold for at least one of the fuel and oxidant; and

f) an opening extending through the substrate under the chamber, the opening communicating with the chamber, whereby the opening is adapted for flow of at least one of the fuel and oxidant into the chamber.

43. The fuel cell of claim 42, wherein the exterior surface of the integral manifold comprises electrolyte material.

44. The fuel cell of claim 42, further comprising a current collector, the current collector comprising a patterned film of conductive material.

45. The fuel cell of claim 44, wherein at least a portion of the current collector is disposed on an exterior surface of the integral manifold.

46. The fuel cell of claim 44, wherein at least a portion of the current collector is disposed adjacent to an exterior surface of the integral manifold.

47. The fuel cell of claim 42, further comprising a combustor for combustion of depleted fuel.

48. The fuel cell of claim 47, wherein the combustor comprises a patterned film of a catalyst suitable for combustion of the fuel, the patterned film of catalyst being disposed within the at least one chamber.

49. The fuel cell of claim 48, wherein the patterned film of catalyst is disposed within the integral manifold.

50. A manifold for a fuel cell having an electrolyte, an anode, and a cathode, the manifold comprising:

a) a substrate; and

b) an elongate roof affixed to the substrate and enclosing an elongate, generally semi-cylindrical interior volume communicating with the electrolyte and with at least one of the anode and cathode of the fuel cell.

51. The manifold of claim 50, further comprising an opening extending through the substrate, and wherein the interior volume of the manifold further communicates with the opening through the substrate.

52. The manifold of claim 50, further comprising a porous substance substantially filling the interior volume of the manifold.

53. The manifold of claim 50, further comprising a catalyst disposed within the manifold.

54. The manifold of claim 53, wherein the catalyst is a combustion catalyst.

55. The manifold of claim 50, further comprising a current collector disposed on the roof of the manifold.

56. A fuel cell of the type using a fuel and an oxidant, the fuel cell comprising:

a) an electrolyte;

b) a cathode in contact with the electrolyte;

c) an anode spaced apart from the cathode and in contact with the electrolyte; and

d) an integral manifold for supplying at least one of the fuel and oxidant; and

e) a combustor within the integral manifold, the combustor comprising a patterned film of catalyst suitable for combustion of the fuel.

57. A MEMS-based fuel cell of the type using a fuel and an oxidant, the fuel cell comprising:

a) a substrate;

b) an electrolyte in contact with the substrate;

c) a cathode in contact with the electrolyte;

d) an anode spaced apart from the cathode and in contact with the electrolyte; and

e) integral means for supplying at least one of the fuel and oxidant, the supplying means extending over at least a portion of the electrolyte and over at least a portion of one of the anode and cathode.

58. The MEMS-based fuel cell of claim 57, further comprising:

f) means for flowing at least one of the fuel and oxidant through the substrate and communicating with the integral means for supplying at least one of the fuel and oxidant.

59. The MEMS-based fuel cell of claim 57, further comprising:

g) integral means for exhausting at least one of depleted fuel and depleted oxidant.

60. The MEMS-based fuel cell of claim 59, further comprising:

h) means for flowing at least one of the depleted fuel and depleted oxidant through the substrate, communicating with the integral means for exhausting at least one of depleted fuel and depleted oxidant.

61. The MEMS-based fuel cell of claim 59, further comprising:

i) integral means for combustion of depleted fuel, the means for combustion being disposed within the integral means for exhausting.

62. A method for using a manifold in a MEMS-based fuel cell of the type using a fuel and an oxidant, the method comprising the steps of:

a) providing a substrate carrying an electrolyte, a cathode in contact with the electrolyte, and an anode spaced apart from the cathode and in contact with the electrolyte;

b) providing an integral manifold for at least one of the fuel and oxidant, the integral manifold extending over at least a portion of the electrolyte and at least a portion of one of the anode and cathode; and

c) supplying at least one of the fuel and oxidant through the integral manifold to the electrolyte and to at least one of the anode and cathode.

63. The method of claim 62, wherein an opening extends through the substrate and communicates with the integral manifold, the method further comprising the step of:

d) flowing at least one of the fuel and oxidant through the opening extending through the substrate and into the integral manifold.

64. The method of claim 62, wherein an opening extends through the substrate and communicates with the integral manifold, the method further comprising the step of:

e) flowing at least one of the depleted fuel and oxidant out of the integral manifold and through the opening extending through the substrate.